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PATENT APPLICATION

REMOTE MONITORING AND CONTROL METHOD AND APPARATUS FOR AN INFORMATION DISTRIBUTION SYSTEM

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REMOTE MONITORING AND CONTROL METHOD AND APPARATUS FOR AN INFORMATION DISTRIBUTION SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

This application claims the benefit of U.S. provisional Application Serial No. (Attorney Docket No. 19880-003800), entitled "METHOD AND APPARATUS FOR INTERACTIVE PROGRAM GUIDE AND ADVERTISING SYSTEM," filed November 27, 2000, which is incorporated herein by reference in its entirety for all purposes.

BACKGROUND OF THE INVENTION

The present invention relates to communication systems in general. More specifically, the invention relates to techniques to efficiently deliver interactive program guide (IPG) and other multimedia information in a server-centric system.

Over the past few years, the television industry has seen a transformation in a variety of techniques by which its programming is distributed to consumers. Cable television systems are doubling or even tripling system bandwidth with the migration to hybrid fiber coax (HFC) cable plant. Direct broadcast satellite (DBS) systems have also emerged as a viable alternative to customers unwilling to subscribe to local cable systems. A variety of other approaches have also been attempted, which focus primarily on high bandwidth digital technologies, intelligent two-way set top terminals, or other methods to try to offer services differentiated from those of standard cable and over-the-air broadcast systems.

For a system designed to distribute information (e.g., programming, guide data, and so on) to a large number of terminals, it is very important to maintain the system up and running at all times and to minimize down time. This typically requires constant (24-hour) monitoring of the operational status of the system elements, spotting for potential problems, and correcting any problems that may arise. Technician and/or other personnel may be employed on-site to stand on alert and to remedy any problems that may arise.

However, in certain instances, the necessary personnel may not be available on-site to monitor the system. Moreover, the on-site personnel may require additional assistance from other personnel whom may be located off-site. For these and

other reasons, remote monitoring and control of the system by off-site personnel is highly desirable.

SUMMARY OF THE INVENTION

The present invention provides techniques to remotely monitor and control operations performed by one or more head-ends (or servers) in an information distribution system. In one implementation, a monitor and control unit communicates with various elements (e.g., an IPG service manager and a session manager) within each head-end to receive information relating to the operation of the head-end. This information may include status and/or indications of possible error conditions relating to (1) various operations (e.g., encoding, multiplexing, and so on) performed by the head-end, (2) the transport streams being transmitted from the head-end, and (3) other aspects of the system. The received information may then be forwarded to one or more remote devices (e.g., pagers, cellular phones, PDAs, and so on) designated to receive the information. Various monitoring and reporting schemes may be employed to respectively receive information from the head-end and report the information to the remote devices, as described in further detail below.

The monitor and control unit may also receive response messages from the remote devices. These messages may include commands to adjust and/or control the operations of the head-end. The messages are forwarded to the appropriate head-end, which may adjust its operation as indicated by the commands.

An embodiment of the invention provides a method for monitoring, from a remote location, operation of a head-end in an information distribution system. In accordance with the method, status relating to one or more operations performed at the head-end are received, and all or a subset of the received status is forwarded to one or more remote devices designated to receive the information. Indications of possible error conditions relating to the operation of the head-end may also be received and forwarded to the remote devices. The status and indications may be received periodically from the head-end, as events occur, or in response to polling the head-end.

The remote devices designated to receive information may be identified, and their capabilities (e.g., text, graphics, and so on) and reporting levels (e.g., all, only error conditions, and so on) may be ascertained. In this way, the monitor and control unit

is able to report the required information to the proper remote devices using the appropriate formats.

The invention further provides other methods and system elements that implement various aspects, embodiments, and features of the invention, as described in further detail below.

The foregoing, together with other aspects of this invention, will become more apparent when referring to the following specification, claims, and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The teachings of the invention can be readily understood by considering the following detailed description in conjunction with the accompanying drawings.

FIG. 1 is a block diagram of an embodiment of an information distribution system that can be used to provide interactive program guide (IPG) and is capable of implementing various aspects of the invention;

FIG. 2A is a diagram of a specific design of an IPG page used to present a program listing and other information to viewers;

FIGS. 2B and 2C are diagrams of an embodiment of a background video and a guide video, respectively, for the IPG page shown in FIG. 2A;

FIGS. 3A through 3C are diagrams of data structures (i.e., matrices) of program guide data for a group of IPG pages, and which may be used in conjunction with picture-based encoding, slice-based encoding, and temporal slice persistence encoding, respectively;

FIG. 3D is a diagram that shows an implementation of demand-cast with the use of temporal slice persistence technique;

FIG. 4 is a diagram of a specific design of a channel information window (i.e., a spotlight window) that can also be used to efficiently provide IPG information;

FIG. 5 is a block diagram of an embodiment of terminal capable of providing a display of a user interface and implementing various aspects of the invention;

FIG. 6 is a block diagram of an information distribution system capable of performing remote monitoring and control; and

FIGS. 7 and 8 are diagrams of an embodiment of status monitors that may be provided for information respectively received from an IPG service manager and a session manager within a head-end of the distribution system.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common within a figure.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

A. SYSTEM

FIG. 1 is a block diagram of an embodiment of an information distribution system 100 that can be used to provide interactive program guide (IPG) and is capable of implementing various aspects of the invention. Distribution system 100 includes a head-end 102, (optional) local neighborhood equipment (LNE) 104, one or more distribution nodes 106 (e.g., a hybrid fiber-coax network), and a number of terminals 108 (e.g., set top terminals). Each LNE 104 may serve one or more distribution nodes 106, and each distribution node 106 is typically associated with a respective neighborhood that includes a number of terminals 108.

Head-end 102 produces a number of digital streams that contain encoded information in (e.g., MPEG-2) compressed format. These digital streams are then modulated using a modulation technique that is compatible with a communication channel 162 that couples head-end 102 to LNE 104 and/or distribution node 106. LNE 104 is typically located away from head-end 102. LNE 104 selects data for viewers in the LNE's neighborhood and re-modulates the selected data into a form suitable for transmission to the associated distribution node(s) 106. Although system 100 is depicted as having head-end 102 and LNE 104 as separate elements, the functions of LNE 104 may be incorporated into head-end 102. Also, the elements of system 100 can be physically located anywhere, and need not be near each other.

In distribution system 100, program streams may be continually transmitted from the head-end to the terminals (i.e., broadcast) or may be addressed to particular terminals that requested the information via an interactive menu (referred to herein as "demand-cast"). An interactive menu structure suitable for requesting video-on-demand (VOD) is disclosed in commonly assigned U.S. Patent Application Serial No. 08/984,427, entitled "METHOD AND APPARATUS FOR PROVIDING A MENU

STRUCTURE FOR AN INTERACTIVE INFORMATION DISTRIBUTION SYSTEM," filed December 3, 1997, and incorporated herein by reference. Another example of an interactive menu suitable for requesting multimedia services is an interactive program guide disclosed in commonly assigned U.S. Patent Application Serial No. 09/293,526, entitled "DATA STRUCTURE AND METHODS FOR PROVIDING AN INTERACTIVE PROGRAM GUIDE," filed April 15, 1999, and incorporated herein by reference.

To assist a viewer to select programming, head-end 102 produces information that can be assembled to create an "IPG page" such as that shown in FIG. 2A. Head-end 102 produces the components of the IPG page as bitstreams that are compressed prior to transmission. Terminals 108 thereafter receive and demodulate the transmission from head-end 102 and decode the compressed bitsteams to retrieve the IPG pages.

Within distribution system 100, a video source 112 supplies one or more video sequences for a video portion of the IPG pages (also referred to herein as "barker" videos), an audio source 114 supplies one or more audio signals associated with the video sequences, and a guide data source 116 provides program guide data for a guide portion of the IPG pages. The guide data is typically stored and provided in a particular (e.g., text) format, with each guide entry describing a particular program by its title, presentation time, presentation date, descriptive information, channel, and program source. The video sequences, audio signals, and program guide data are provided to an encoder unit 120 within head-end 102.

Encoder unit 120 (which is described in further detail below) compresses the received video sequences into one or more elementary streams, the audio signals into one or more elementary streams, and the guide videos produced from the guide data into one or more elementary streams. The elementary streams can be produced using a number of encoding techniques such as, for example, "picture-based" encoding, "slice-based" encoding, "temporal slice persistence" (TSP) encoding, "strobecast", as well as other types of encoding, or a combination thereof.

Picture-based encoding is described in detail in U.S. Patent Application Serial No. 09/384,394, entitled "METHOD AND APPARATUS FOR COMPRESSING VIDEO SEQUENCES," filed August 27, 1999. Slice-based encoding is described in detail in U.S. Patent Application Serial No. 09/428,066, entitled "METHOD AND

APPARATUS FOR TRANSMITTING VIDEO AND GRAPHICS IN COMPRESSED FORM," filed October 27, 1999. Temporal slice persistence encoding is described in detail in U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410), entitled "TEMPORAL SLICE PERSISTENCE METHOD AND APPARATUS FOR DELIVERY OF INTERACTIVE PROGRAM GUIDE," filed October 10, 2000. Strobecast encoding and delivery is described in detail in U.S. Patent Application Serial No. 09/687,662, entitled "EFFICIENT DELIVERY OF INTERACTIVE PROGRAM GUIDE USING DEMAND-CAST," filed October 12, 2000. These applications are assigned to the assignee of the invention and incorporated herein by reference.

In the specific embodiment shown in FIG. 1, encoder unit 120 includes a guide data grid generator 122, a compositor unit 124, video encoders 126a and 126b, and an audio encoder 128. Additional video and/or audio encoders may also be included within encoder unit 120, depending on the particular head-end design. Guide data grid generator 122 receives and formats the guide data into a "guide grid", e.g., guide grid region 212 in FIG. 2A.

Compositor unit 124 receives and combines the guide grid from grid generator 122 and a video sequence from video source 112, and may further insert advertising video, advertiser or service provider logos, still graphics, animation, other information, or a combination thereof. In an embodiment, compositor unit 124 provides a background video (e.g., as shown in FIG. 2B) to a first video encoder 126a and a guide video (e.g., as shown in FIG. 2C) to a second video encoder 126b. For picture-based encoding, compositor unit 124 provides a composed video (e.g., as shown in FIG. 2A) to one video encoder. A number of encoders can be used to encode in parallel a number of composed videos for a number of IPG pages, with each IPG page including different guide content.

In an embodiment, video encoder 126a is a real-time (e.g., MPEG-2) encoder that encodes the background video using a particular encoding technique, and provides one or more (e.g., MPEG-2 compliant) bitstreams for the background portion of the IPG page. In an embodiment, video encoder 126b is a (e.g., software-based) encoder that encodes the guide video using a particular encoding technique, and provides one or more bitstreams that collectively represent all or a portion of the guide grid. Each video encoder 126 is designed to efficiently and effectively encode the respective input video, and may be operated in accordance with slice-based, picture-based, temporal slice

persistence, or some other encoding technique. Audio encoder 128 (e.g., an AC-3 encoder) receives and encodes the audio signals to form a bitstream for the audio signals. The video and audio encoders provide a number of elementary streams containing (e.g., picture-based or slice-based) encoded video and audio information.

For some applications such as picture-in-picture (PIP) or picture-in-application (PIA), compositor unit 124 may receive a number of video sequences and form a composed video having included therein the video sequences in scaled form (i.e., reduced in size). For example, nine video sequences may be compressed and arranged into a 3x3 grid. Video encoder 126a then receives and (e.g., slice-based) encodes the composed video and produces a number of elementary streams, one stream for each video sequence. Each video sequence can thereafter be individually transmitted from the head-end and flexibly recombined with other (e.g., guide) data and/or video at the terminal (e.g., to implement PIP or PIA). PIP and PIA are described in further detail in U.S. Patent Application Serial No. 09/635,508, entitled "METHOD AND APPARATUS FOR TRANSITIONING BETWEEN INTERACTIVE PROGRAM GUIDE (IPG) PAGES," filed August 9, 2000, assigned to the assignee of the invention and incorporated herein by reference.

A controller 130 couples to encoder unit 120 and manages the overall encoding process such that the video encoding process is temporally and spatially synchronized with the grid encoding process. For slice-based encoding, this synchronization can be achieved by defining the slice start and stop (macroblock) locations for each slice and managing the encoding process based on the defined slices. Slices may be defined, for example, according to the objects in the IPG page layout.

The encoding process generates a group of pictures (GOP) structure having "intra-coded" (I) pictures and "predicted" (P and B) pictures. For slice-based encoding, the I pictures include intra-coded slices and the P and B pictures include predictive-coded slices. In an embodiment, the intra-coded slices are separated from the predictive-coded slices and transmitted from the head-end via separate packet identifiers (PIDs). Although not shown in FIG. 1, the coded slices may be stored in a storage unit. The individual slices can thereafter be retrieved from the storage unit as required for transmission from the head-end.

A transport stream generator (TSG) 140 receives and assembles the elementary streams from the video and audio encoders into one or more transport streams.

Transport stream generator 140 further manages each transport stream and communicates with a session manager 150 to form and/or tear down transport streams. In an embodiment, each transport stream is an MPEG-compliant transport stream. In this case, transport stream generator 140 may send program tables to terminals 108 in a private section of the MPEG transport stream. Such table may include a list of available streams along with the address of the source transport stream generator and other information to identify the particular transport stream to which the table belongs.

Session manager 150 manages the delivery of IPG pages to terminals 108 located on one or more distribution nodes 106. In an embodiment, each distribution node 106 is served by a respective set of one or more transport streams generated by a transport stream generator assigned to that node. The transport streams for each distribution node include broadcast streams (e.g., for IPG pages continually sent from the head-end) and demand-cast streams (e.g., for IPG pages sent from the head-end in response to requests from the terminals). For some implementations, session manager 150 may monitor the demand-cast streams and usage by terminals 108 and direct the appropriate transport stream generator to generate or tear down demand-cast streams.

An in-band delivery system 160 (e.g., a cable modem) receives and modulates the transport streams from transport stream generator 140 using a modulation format suitable for transmission over communication channel 162, which may be, for example, a fiber optic channel that carries high-speed data from the head-end to a number of LNE and/or distribution nodes. Each LNE selects the programming (e.g., the IPG page components) that is applicable to its neighborhood and re-modulates the selected data into a format suitable for transmission over the associated distribution node(s).

Although not shown in FIG. 1 for simplicity, LNE 104 may include a cable modem, a slice combiner, a multiplexer, and a modulator. The cable modem demodulates a signal received from the head-end and extracts the coded video, guide, data, and audio information from the received signal. The coded information is typically included in one or more transport streams. The slice combiner may recombine the received video slices with the guide slices in an order such that a decoder at the terminals can easily decode the IPG without further slice re-organization. The multiplexer assigns PIDs for the resultant combined slices and forms one or more (e.g., MPEG-compliant) transport streams. The modulator then transmits the transport stream(s) to the distribution node(s).

LNE 104 can be programmed to extract specific information from the signal transmitted by the head-end. As such, the LNE can extract video and guide slices that are targeted to the viewers served by the LNE. For example, the LNE can extract specific channels for representation in the guide grid that can be made available to the viewers served by that LNE. In such case, unavailable channels to a particular neighborhood would not be depicted in a viewer's IPG. The IPG may also include targeted advertising, e-commerce, program notes, and others. To support such features, each LNE may recombine different guide slices with different video slices to produce IPG pages that are prepared specifically for the viewers served by that particular LNE. Other LNEs may select different IPG component information that is relevant for their associated viewers. A detailed description of LNE 104 is described in the aforementioned U.S. Patent Application Serial No. 09/635,508.

For a server-centric distribution system, the program guide resides at the head-end and a two-way communication system, via a back channel 164, is utilized to support communication with the terminals for delivery of the program guide. Back-channel 164 can be used by the terminals to send requests and other messages to the head-end, and may also be used by the head-end to send messages and certain types of data to the terminals. An out-of-band delivery system 170 facilitates the exchange of data over the back channel and forwards terminal requests to session manager 150.

Other elements within head-end 102 may also interface with out-of-band delivery system 170 to send information to terminal 108 via the out-of-band network. Fort example, a spotlight server that produces a spotlight user interface (described below) may interface with out-of-band delivery system 170 directly to send spotlight data to terminals 108. Off the shelf equipment including network controllers, modulators, and demodulators such as those provided by General Instrument Corporation can be used to implement out-of-band delivery system 170.

Distribution system 100 is described in further detail in the aforementioned U.S. Patent Application Serial Nos. 09/687,662 and (Attorney Docket No. 19880-003410). One specific implementation of head-end 102 is known as the DIVA™ System provided by DIVA Systems Corporation.

B. INTERACTIVE PROGRAM GUIDE

A unique way of providing programming schedule and listing to viewers is a server-centric approach. In this approach, the complete program guide information spanning a particular time period (e.g., two weeks of programming) is generated at a head-end and sent to the terminals in a display-ready compressed video format.

FIG. 2A is a diagram of a specific design of an IPG page 200 used to present a program listing and other information to viewers. In this design, IPG page 200 includes a guide region 210, a video region 220, an icon region 240, a program description region 250, a logo region 260, and a time-of-day region 270. Other designs for the IPG page with different layouts, configurations, and combinations and arrangements of regions and objects can be contemplated and are within the scope of the invention.

In an embodiment, guide region 210 includes a guide grid region 212 and a time slot region 218. Time slot region 218 includes a first time slot object 218a and a second time slot object 218b that indicate the (e.g., half-hour) time slots for which program guide is being provided on the IPG page. Guide grid region 212 is used to display program listing for a group of channels. In the design shown in FIG. 2A, the program listing shows the available programming in two half-hour time slots. Guide grid region 212 includes a number of channel objects 214a through 214j used to display program information for the group of channels. A pair of channel indicators 216a and 216b within guide grid region 212 identifies the current cursor location.

Program description region 250 is used to present descriptive information relating to a particular program selected from the program listing, or may be used to present other information. Video region 220 may be used to display images, videos, text, or a combination thereof, which may be used for advertisements, previews, or other purposes. In the design shown in FIG. 2A, video region 220 displays a barker video. Logo region 260 may include a logo of a service operator or other entity, and may be optionally displayed. Time-of-day region 270 may be configured by the user and may also be optionally displayed.

Icon region 240 is used to display various icons. Each icon can represent a filter or a link to either another IPG page or a particular interface. Each filter selects a particular type of programming to be included in the program listing shown in guide region 210. For example, a "Pay Per View" (PPV) icon 241 may be a filter that selects

only PPV programming to be included in the program listing. A "Favorites" icon 242 may be a filter that selects only channels designated by the viewer to be among his or her favorites. A "Movies" icon 243 may be a filter that selects only movies or movie channels. A "Kids" icon 244 may be a filter that selects only channels for children or programming appropriate or produced for viewing by children. A "Sports" icon 245 may be a filter that selects only sports channels or sports-related programming. A "Music" icon 246 may be a link to a music interface. And an "Options" icon 247 may be a link to a menu of IPG options that the viewer may select amongst. Such options may include (1) configuration and selection/deselection information of IPG related services, (2) custom information for deactivating some of the filters or accessing a custom condensed listing menus, and (3) other features and functionality.

FIG. 2B is a diagram of an embodiment of a background video 280 for IPG page 200. In this embodiment, background video 280 includes video region 220, icon region 240, program description region 250, and logo region 260. As noted above, background video 280 can be efficiently (slice-based) encoded by a video encoder. In other designs, background video 280 may include additional and/or different regions than that shown in FIG. 2B.

FIG. 2C is a diagram of an embodiment of a guide video 290 for IPG page 200. In this embodiment, guide video 290 includes guide region 210, which includes guide grid region 212 and time slot region 218. Guide video 290 can also be efficiently (slice-based) encoded by a video encoder. In other designs, guide video 290 may include additional and/or different regions than that shown in FIG. 2C.

As shown in FIG. 2C, two program titles are provided for each channel object 214 in guide grid region 212, with each title corresponding to a respective half-hour time slot. In an embodiment, a "mask or reveal" feature can be used to display (i.e., reveal) a desired program title and hide (i.e., mask) the other program title. For example, channel 12 includes the program titles "Hemingway" and "Dragon Tails". If the 9:00-9:30 time slot is selected (as shown in FIG. 2A), the program title "Hemingway" can be revealed and the other program title "Dragon Tails" can be masked from view. And if the 9:30-10:00 time slot is selected, the program title "Hemingway" can be masked and the other program title "Dragon Tails" can be revealed. The underlying video frame to be encoded can thus include various objects and items, some of which may be shown and

others of which may be hidden. This mask or reveal technique can be used for any region of the IPG page.

The mask or reveal feature and the user interaction processing are described in the aforementioned U.S. Patent Application Serial Nos. 09/293,526 and 08/984,427.

A program guide for a large number of channels for a long time period can be very extensive. For example, 480 IPG pages would be needed to provide program guide for two weeks of programming for 200 channels, if each IPG page includes a program listing for 10 channels in two half-hour time slots as shown in FIG. 2A. A large amount of system resources (e.g., bandwidth) would be needed to continually transmit the complete program guide.

In an embodiment, to conserve system resources, only a limited number of IPG pages are continually sent (broadcast) by the head-end, and remaining IPG pages may be sent as requested by viewers. The specific number of IPG pages to be broadcasted and their selection are dependent on the particular system implementation, and may be defined by a time depth and a program depth for the program guide. The time depth refers to the amount of time programming for a particular channel group is provided by the broadcast video PIDs. And the channel depth refers to the number of channels available through the program guide (in comparison to the total number of channels available in the system).

In an embodiment, a number of video PIDs can be used to send the program guide for the current and (possibly) near look-ahead time slots, one or more audio PIDs can be used to send an audio barker, and (optionally) one or more data PIDs (or other data transport method) can be used to send the program description data, overlay data, and/or other data. The elementary streams carrying the IPG are sent in one or more transport streams.

For the portion of the program guide that is broadcasted by the head-end, a viewer is able to quickly retrieve and display IPG pages formed from the broadcast streams whenever desired.

If the viewer desires a program listing or other contents that is not provided by the broadcast streams, then a demand-cast session may be initiated, for example, as described in the aforementioned U.S. Patent Application Serial Nos. 09/687,662 and (Attorney Docket No. 19880-003410). For this demand-cast session, the

terminal sends a message to the head-end, via the back channel, requesting the desired contents. The head-end processes the request, retrieves the desired contents from an appropriate source, generates a video stream for the desired contents and assigns it with another video PID (and related audio and data PIDs, if any), and incorporates the video stream into a transport stream. Preferably, the desired video stream is inserted into the transport stream currently being tuned/selected by the requesting terminal or sent in another transport stream. The head-end further informs the terminal which PID should be received and from which transport stream the demand-cast video stream should be demultiplexed. The terminal then retrieves the desired video stream from the transport stream.

C. DATA STRUCTURES AND ENCODING TECHNIQUES

FIG. 3A is a diagram of a data structure 300 (i.e., a matrix) of program guide data for a group of IPG pages, and which may be used in conjunction with picture-based encoding. In this representation, the horizontal axis represents the video sequences for different IPG pages to be transmitted, and the vertical axis represents time indices for the video sequences. In this specific example, ten video sequences are generated and labeled as IPG pages 1 through 10. Each video sequence is composed of a time sequence of pictures. In this specific example, each group of 15 pictures for each video sequence forms a group of pictures (GOP) for that video sequence. Matrix 300 is illustratively shown to include ten GOPs for ten IPG pages, but can be designed to have any defined MxN dimension.

As shown in FIG. 3A, matrix 300 is a two-dimensional array of elements, with each element representing a picture (or frame). For simplicity, each element in matrix 300 is illustratively shown to include a guide portion and a video portion on the left and right halves of the picture, respectively. The element in the first column of the first row represents the guide portion (g_1) and video portion (v_1) of IPG page 1 at time index t_1, the element in the second column of the first row represents the guide portion (g_2) and video portion (v_1) of IPG page 2 at time index t_1, and so on. In the specific example shown FIG. 3A, the guide portion for each IPG page is different (i.e., g_1, g_2, …, g_{10}) but the video portion (e.g., v_1) is common for all ten IPG pages.

Each of the ten video sequences in matrix 300 can be coded as a GOP. For example, the video sequence for IPG page 1 can be coded as a GOP comprised of the

coded picture sequence: I1, B1, B1, P1, B1, B1, P1, B1, B1, P1, B1, B1, P1, B1, and B1, where I represents an intra-coded picture, P represents a uni-directionally predictive-coded picture, and B represents a bi-directionally predictive-coded picture.

In the example shown in FIG. 3A, matrix 300 includes a group of intra-coded pictures 312 and a group of predictive-coded pictures 314 that can be used to fully represent the ten IPG pages. In an embodiment, intra-coded picture group 312 includes ten intra-coded pictures at time index t_1 for the ten IPG pages. These intra-coded pictures can be assigned to PIDs 1 through 10, which may also be referred to as I-PIDs 1 through 10 to denote that these PIDs include intra-coded pictures. In an embodiment, predictive-coded picture group 314 includes 14 predictive-coded pictures of one of the IPG pages for time indices t_2 through t_{15}. Predictive-coded picture group 314 is also assigned a PID, and may also be referred to as the base-PID or PRED-PID to denote that this PID includes predictive-coded pictures. The base-PID may comprise the following picture sequence: B1, B1, P1, B1, B1, P1, B1, B1, P1, B1, B1, P1, B1, and B1.

For each IPG page, between time t_1 to t_{15}, the guide portion does not change and only the video portion changes. In each column, the 14 prediction error frames contain zero data for the guide portion and video prediction error for the video portion. Therefore, the content of the base-PID is the same for each IPG page and may be sent only once per group of IPG pages in the matrix for each GOP period.

If a viewer wants to view the guide data for a particular group of channels (i.e., a particular IPG page), a demultiplexer at the terminal selects the I-PID for the selected IPG page and recombines the selected I-PID with the base-PID to produce a recombined stream, which is then decoded by the video decoder. Picture-level recombination is described in further detail in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410).

FIG. 3B depicts an embodiment of a data structure 320 that may be used in conjunction with slice-based encoding. In this example, ten IPG pages are available, with each page represented by a respective guide portion (g) and a common video portion (v). For example, IPG page 1 is represented as (g_1/v_1), IPG page 2 is represented as (g_2/v_1), and so on. In data structure 320, ten guide portions g_1 through g_{10} are associated with the video portion (v_1). Slice-based encoding is described in the aforementioned U.S. Patent Application Serial Nos. (Attorney Docket No. 19880-003410) and 09/635,508.

As shown in FIG. 3B, the coded slices for the guide and video portions of the IPG pages can be assigned to a number of PIDs. In FIG. 3B, only the content that is assigned a PID is delivered to the terminals. The intra-coded guide portions g_1 through g_{10} are assigned to PID 1 through PID 10, respectively. One of the common intra-coded video portion v_1 (e.g., for IPG page 10) is assigned to PID 11. In this form, substantial bandwidth saving is achieved by delivering the intra-coded video portion v_1 only once. Finally, the predictive-coded pictures g_1/v_2 through g_1/v_{15} are assigned to PID 12. Again, a substantial saving in bandwidth is achieved by transmitting only one group of fourteen predictive-coded pictures, g_1/v_2 through g_1/v_{15}. The PID assignment and decoding processes are described in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410).

FIG. 3C is a diagram of a data structure 340 that can be used in conjunction with temporal slice persistence encoding. Data structure 340 is a matrix representation for program guide data for a number of IPG pages based on the partitioning of the IPG page shown in FIGS. 2B and 2C. As shown by the shaded portions in FIG. 3C, a video sequence is formed which contains only the video portion of the IPG page (i.e., the portion containing time-varying information). In an embodiment, the coded video sequence contains only slices that belong to the video region. The coded video sequence is assigned a particular PID (e.g., V-PID) and transmitted from the head-end.

For each IPG page, the guide portion (i.e., the portion containing the information specific to that IPG page) is sent in a separate picture frame. Since the guide portion does not change over time, only one picture for each GOP is coded and transmitted. The coded guide frame contains only the slices that belong to the guide portion of a frame. The slice-coded guide portion for each IPG page is assigned a respective PID (e.g., G-PID) and also transmitted from the head-end.

The presentation times of the guide frames and motion video frames are assigned in accordance with a "temporal slice persistence" fact. In an embodiment (not represented in FIG. 3C), the guide PIDs (i.e., G-PID 1, G-PID 2, and so on) are time stamped to be presented at the end of each GOP at t=15. At t=15, the last motion video frame in the GOP is dropped and the viewer-selected guide page is presented. To achieve this, the video decoder re-combines the selected guide G-PID (e.g., G-PID 1) and the

video V-PID via one of the picture-based recombination methods described in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410).

The selected guide page is decoded and displayed at t=15, with only the region that contains the guide portion slices being updated on the screen. From that time on, the guide portion of the screen is not updated (i.e., the guide slices temporally persist on the screen) until the viewer selects another guide page. This selection then updates the slices in the guide portion and rewrites the new guide portion on the screen. Similarly, the V-PID frames only change the video portion of the screen and do not update the guide portion, since these motion video frames do not include slices in the guide portion.

The embodiments disclosed with respect to FIG. 3C can be used for broadcast of IPG pages and can further be used for a demand-cast of IPG pages in response to viewer requests. For demand-cast, the head-end can time stamp the requested page to be processed and quickly displayed on the screen in a suitable time index within a GOP to reduce delays. The guide frames and motion video frames can be encoded, delivered, decoded, and displayed in various manners, as described in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410).

In another embodiment that is supported by FIG. 3C, the V-PID is encoded to include P and B pictures (e.g., a GOP of I-B-B-P-B-B-P-B-B-P-B-B-P-B-B), and any B picture in the V-PID can be dropped and replaced with a B-coded guide frame that includes "intra-coded" macroblocks. This can be achieved by adjusting the encoding threshold selection that decides whether a macroblock is better to be encoded as intra-coded or as predictive-coded. Any B-coded frame can be dropped and replaced since it is not used as a reference for prediction by any other pictures in a GOP. The guide page frames can be time stamped to be presented, for example, at t=2. Other embodiments for encoding and decoding the guide frames are described in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410).

FIG. 3D is a diagram that shows an implementation of demand-cast with the use of temporal slice persistence technique. In the example shown in FIG. 3D, a viewer request is received and processed by the head-end, and the requested guide PID is time stamped to be displayed at t=3. In this example, the V-PID is coded to include B frames (e.g., I-B-B-P-B-B-P...), and the B frame at t=3 is dropped and replaced with a B-coded requested guide PID that includes intra-coded macroblocks. The B frame of the V-

PID can be dropped at anytime in a GOP since it is not used as a reference for prediction by any other frame in the GOP.

The temporal slice persistence technique can be advantageously employed in a broadcast scenario whereby a large number of guide PIDs (in the order of hundreds) can be efficiently delivered. Since the guide PIDs do not carry full motion barker video, huge bandwidth savings can be achieved. The barker video can be sent as a separate video stream (e.g., V-PID or another PID). The temporal slice persistence technique can also be used to implement other combinations of coding and decoding of guide frames, full motion video frames, and (possibly) other multimedia information in a GOP. The temporal slice persistence technique employs picture-based recombination techniques with slice-based sub-picture updating mechanisms, as described in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410).

By exploiting known characteristics of the IPG pages and the temporal slice persistence technique, the transmission of redundant information can be minimized, for example, by employing efficient client-server communication and acknowledgement techniques. For example, the guide portion of a requested IPG page may be sent a limited number of times (e.g., once) in response to a viewer request for the page. This "strobecast" of IPG pages can greatly reduce the load for demand-cast, and may (possibly) be used for the delivery of other contents from the head-end. Strobecast techniques are described in detail in the aforementioned U.S. Patent Application Serial No. 09/687,662.

D. SPOTLIGHT WINDOW

FIG. 4 is a diagram of a specific design of a channel information window 400 (also referred to as a "spotlight window") that can also be used to efficiently provide IPG information. The spotlight window can be generated and overlay on top of a video display (e.g., whenever selected by a viewer). In this design, spotlight window 400 includes a specific portion 410, a local portion 420, and a common portion 430. Specific portion 410 includes information specific to a particular broadcast channel being described by spotlight window 400. Local portion 420 includes information targeted for delivery to the terminals within a particular locality. And common portion 430 includes features that are common for a number of spotlight windows (i.e., the background that is common for all broadcast channels and localities). FIG. 4 shows a specific design, and

additional and/or different information, layouts, configurations, and arrangements may also be provided for each portion of spotlight window 400.

In the design shown in FIG. 4, specific portion 410 includes the channel number (e.g., "13"), the broadcast channel name (e.g., "USA"), the program title (e.g., "Tremors II: ..."), the time period of the program (e.g., "9:00-11:00"), the program rating (e.g., "PG"), the copyright or release year (e.g., "1998"), and a brief description (e.g., "The creature from ....").

Local portion 420 includes, for example, a logo for the service provider or other branding related information. A different logo may be provided for each region served by a different service provider. Local portion 420 may also be partitioned into a number of smaller sub-portions, with each sub-portion being used to provide different information (e.g., targeted advertisements, locality specific announcements) and may further be associated with a particular localization level (e.g., an entire region, a neighborhood, or a set of terminals).

Common portion 430 includes a filter icon region 440 and an operational icon region 450. Filter icon region 440 includes a number of filter icons used to filter the programs to be displayed in the program guide, e.g., an "All" filter icon, a "Fav" or favorites filter icon, a "Movies" filter icon, a "Kids" filter icon, and a "Sports" filter icon. These filter icons can be designed to provide filtering functionality. Operational icon region 450 includes a close caption icon ("CC"), a secondary audio programming icon ("SAP"), and a stereo icon ("⋈").

In an embodiment, all or portions of the spotlight window are generated at the head-end and sent to the terminals. In this manner, the head-end has control over the particular arrangement (i.e., the layout and configuration) for the spotlight window and the information to be included in the various fields and portions of the spotlight window. Bitmap for all or portions the spotlight window may be encoded at the head-end, packetized, and sent to the terminals (e.g., via an out-of-band network). The spotlight data can be processed by a separate spotlight server that does not interfere with the operations of the session manager or the transport stream processor to send the spotlight data via the out-of-band network.

Techniques for generating, encoding, and delivering spotlight window is described in U.S. Patent Application Serial No. 09/691,495, entitled "SYSTEM AND

METHOD FOR LOCALIZED CHANNEL INFORMATION WINDOW," filed October 18, 2000, assigned to the assignee of the invention and incorporated herein by reference.

E. TERMINAL

FIG. 5 is a block diagram of an embodiment of terminal 108, which is also referred to as a set top terminal (STT) or user terminal. Terminal 108 is capable of producing a display of a user interface and implementing various aspects of the invention. Terminal 108 includes a tuner 512, a demodulator 514, a transport demultiplexer (DEMUX) 518, an audio decoder 520, a video decoder 530, an on-screen display (OSD) processor 532, a video compositor 534, a frame store memory 536, a controller 550, and a modulator 570. User interaction is supported via a remote control unit 580. Tuner 512 receives a radio frequency (RF) signal comprising, for example, a number of quadrature amplitude modulated (QAM) signals from a downstream (forward) channel. In response to a control signal TUNE, tuner 512 tunes to and processes a particular QAM signal to provide an intermediate frequency (IF) signal. Demodulator 514 receives and demodulates the IF signal to provide an information stream (e.g., an MPEG transport stream) that is sent to transport stream demultiplexer 518.

Transport stream demultiplexer 518, in response to a control signal TD produced by controller 550, demultiplexes (i.e., extracts) an audio stream A and a video stream V. The audio stream A is provided to audio decoder 520, which decodes the audio stream and provides a decoded audio stream to an audio processor (not shown) for subsequent processing and presentation. The video stream V is provided to video decoder 530, which decodes the compressed video stream V and provides an uncompressed video stream VD to video compositor 534. OSD processor 532, in response to a control signal OSD produced by controller 550, produces a graphical overlay signal VOSD that is provided to video compositor 534.

Video compositor 534 merges the graphical overlay signal VOSD and the uncompressed video stream VD to produce a composed video stream (i.e., the underlying video images with the graphical overlay). Frame store unit 536 receives and stores the composed video stream on a frame-by-frame basis according to the frame rate of the video stream. Frame store unit 536 thereafter provides the stored video frames to a video processor (not shown) for subsequent processing and presentation on a display device. In an embodiment, during transitions between streams for a user interface, the buffers in the

terminal are not reset, and the user interface seamlessly transitions from one screen to another.

Controller 550 includes an input/output (I/O) module 552, a processor 554, support circuitry 556, an infrared receiver (I/R) 558, and a memory 560. Input/output module 552 provides an interface between controller 550 and tuner 512, demodulator 514 (for some designs), transport demultiplexer 518, OSD processor 532, frame store unit 536, modulator 570, and a remote control unit 580 via infrared receiver 558.

Processor 554 interfaces with I/O module 552, support circuitry 556 (which may include power supplies, clock circuits, cache memory, and the like), and a memory 560. Processor 554 also coordinates the execution of software routines stored in memory 560 to implement the features and perform the functions supported by the terminal.

Memory 560 stores software routines that support various functions and features, and further stores data that may be used for the user interface. In the embodiment shown in FIG. 5, memory 560 includes a user interaction routine 562, a PID mapping table 564, an overlay storage 566, and a stream processing routine 568. User interaction routine 562 processes user interactions to perform various functions to provide the desired user interface menu. For example, user interaction routine 562 can implement a mask or reveal feature to display (reveal) the desired portion of the IPG page and hide (mask) the undesired portion. User interaction routine 562 may further perform various functions to achieve a demand-cast for a desired IPG page. The mask or reveal is described in U.S. Patent Application Serial Nos. 09/293,526 and 08/984,427.

Stream processing routine 568 coordinates the recombination of video streams to form the desired video sequences. Stream processing routine 3468 employs a variety of methods to recombine slice-based streams, some of which are described in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003410). In one recombination method, a PID filter 516 within demodulator 514 is utilized to filter the undesired PIDs and retrieve the desired PIDs from the transport stream. The packets to be extracted and decoded to form a particular IPG page are identified by PID mapping table 564. For most recombination methods, after stream processing routine 568 has processed the streams into the proper order, the slices are sent to video decoder 530 (e.g., an MPEG-2 decoder) to form uncompressed IPG pages suitable for display.

Although controller 550 is depicted as a general-purpose processor that may be programmed to perform specific control functions to implement various aspects of the invention, the controller may also be implemented in hardware as an application specific integrated circuit (ASIC).

In a specific design, remote control unit 580 includes an 8-position joystick, a numeric pad, a "Select" key, a "Freeze" key, and a "Return" key. User manipulations of the joystick or keys on the remote control device are transmitted to controller 550 via an infrared (IR) link or an RF link. Controller 550 is responsive to the user manipulations and executes the appropriate portion of user interaction routine 562 to process the user manipulations.

FIG. 5 shows a specific design of terminal 108. Other designs of the terminal can also be implemented to perform the functions described herein, and these alternative designs are within the scope of the invention.

F. REMOTE MONITORING AND CONTROL FOR DISTRIBUTION SYSTEM

An aspect of the invention provides techniques to remotely monitor and control the delivery of interactive program guide (IPG) and other contents.

1. System

FIG. 6 is a block diagram of an information distribution system 600 for delivering programming guide and other contents and which is capable of performing remote monitoring and control, in accordance with an aspect of the invention. System 600 includes one or more head-ends 602. Each head-end 602 may be configured to provide programming, video-on-demand (VOD), interactive program guide, advertisements, and other contents to a number of terminals 108 within its coverage (only one terminal is shown coupled to each head-end in FIG. 6 for simplicity).

The design of head-end 602 is typically dependent on the particular contents to be delivered. To provide interactive program guide, head-end 602a includes an encoding/transport stream generation/delivery unit 620, an IPG service manager 640, and a session manager 650.

Encoding/transport stream generation/delivery unit 620 receives contents (e.g., program guide data, video, audio, and other data) from one or more sources external and/or internal to the head-end. Unit 620 then composes the received contents into one or

more composed videos, encodes the composed videos, and multiplexes the elementary streams generated for the encoded videos into one or more transport streams. Unit 620 further modulates the transport streams into a form suitable for transmission to the terminals. Unit 620 may be implemented as shown in FIG. 1.

IPG service manager 640 interacts with, and typically further controls, various processing elements within encoding/transport stream generation/delivery unit 620. IPG service manager 640 monitors various parameters associated with the encoding, multiplexing, and delivery processes and provides status and diagnostic data that may be used to monitor and manage these processes.

Session manager 650 interacts with IPG service manager 640 and encoding/transport stream generation/delivery unit 620, and further manages the delivery of contents to the terminals. The transport streams transmitted to each distribution node typically include "broadcast" streams (e.g., containing contents continually sent by the head-end) and "demand-cast" streams (e.g., containing contents sent by the head-end in response to requests from the terminals). For some implementations, session manager 650 may monitor the demand-cast streams and usage by the terminals and direct encoding/transport stream generation/delivery unit 620 to generate or tear down demand-cast streams.

In accordance with an aspect of the invention, distribution system 600 further includes a monitor and control unit 660 that couples to head-ends 602 and supports remote monitoring and control of the head-ends. In an embodiment, monitor and control unit 660 communicates with IPG service manager 640 and session manager 650 within each head-end to (possibly request for and) receive status of various operational parameters, which are described in further detail below. Monitor and control unit 660 may communicate with IPG service manager 640 and session manager 650 via various protocols such as, for example, UDP (User Datagram Protocol) and others.

FIG. 7 is a diagram of an embodiment of a status monitor 700 that may be provided by monitor and control unit 660 for information received from IPG service manager 640. In an embodiment, status monitor 700 reports status for various parameters for a particular transport stream from a particular head-end. The reported information may include the status of the data generators, encoders, multiplexers, and other elements located within or coupled to encoding/transport stream generation/delivery unit 620.

Status monitor 700 may be used to report various encoding and delivery parameters. For the specific embodiment shown in FIG. 7, status monitor 700 includes windows 712 through 712c and graphical displays 714a through 714c that respectively provide the current states of the video, audio, and data buffers. These buffers may be monitored to prevent against overflow and underflow conditions. Windows 716a through 716c respectively provide the number of times data is dropped when the video, audio, and data buffers need to be filled with new data. Graphical displays 718 and 720 respectively provide the number of active IPG pages being transmitted and the amount of bandwidth used for requested data.

Graphical displays 722a through 722d respectively provide the current video bit rate, data bit rate, total bit rate, and number of null packets sent for the transport stream. These status may be monitored to determine the loading on the transport stream and to ensure smooth operation. A window 724 displays a selected video that is being transmitted in the transport stream.

Status monitor 700 also includes a selectable box 732a used to activate an audible alert upon occurrence of any one of a set of reportable events, and another selectable box 732b used to enable the paging of (i.e., reporting to) remote devices. These reportable events may be defined via a menu that may be activated, for example, by clicking on a button 740b.

FIG. 8 is a diagram of an embodiment of a status monitor 800 that may be provided by monitor and control unit 660 for information received from session manager 650. Status monitor 800 reports status for various parameters for a particular distribution node, which may be served by a particular transport stream generator within encoding/transport stream generation/delivery unit 620. The reported information typically relates to usage and demands generated by terminals associated with the distribution node.

Status monitor 800 may be used to provide various system parameters. For the specific embodiment shown in FIG. 8, status monitor 800 includes graphical displays 812a through 812c that respectively provide the number of guide users, demand-cast users, and guide pages in use. These parameters may be monitored to determine the system loading on the transport stream being monitored. A window 814 lists the transport streams (i.e., multiplexes) being delivered, and any one of the listed transport streams may be selected for monitoring.

FIGS. 7 and 8 are specific embodiments that show various operational parameters that may be monitored for IPG service manager 640 and session manager 650, respectively. Other parameters may also be monitored, and additional and/or different information may also be reported by the status monitors. The reported information may include status relating to various operations performed at the head-end, statistical information, events, end-to-end system related information such as customer trend, IPG usage information, and so on, some of which are described in the aforementioned U.S. Patent Application Serial No. (Attorney Docket No. 19880-003800). The status monitors may also be designed with different layouts, configurations, and arrangements. These and other variations are within the scope of the invention

For a system used to distribute information (e.g., programming, guide data, and so on) to a large number of terminals, it is often very important to maintain the system up and running at all times and to minimize down time. This typically requires constant (24-hour) monitoring of the operational status of the system elements, spotting for potential problems, and correcting any problems that may arise. Technician and/or other personnel may be employed on-site to stand on alert and to remedy any problems that may arise.

Remote monitoring and control of such distribution system is highly desirable for many reasons. For example, personnel may not be available on-site to monitor the system. Moreover, the on-site personnel may require additional assistance from other personnel whom may be located off-site. For these and other reasons, remote monitoring and control by off-site personnel is highly desirable.

Referring back to the embodiment shown in FIG. 6, monitor and control unit 660 further communicates with a (e.g., Web) server 662 for exchanging data and messages with off-site personnel. Server 662 can further communicate with a number of remote devices 670, and acts as a conduit for exchanging data and messages between monitor and control unit 660 and these remote devices. Such remote devices may include, for example, a cellular phone 670a, a pager 670b, a personal digital assistance (PDA) 670c (e.g., Palm VII from Palm, Inc.), and others.

In an embodiment, the type and format of information to be provided to remote devices 670 are dependent on the particular design and capabilities of the remote devices. For example, since pagers are typically only able to receive text messages, monitor and control unit 660 provides information in text format to these pagers. PDAs,

however, may be able to receive both text and graphics, and monitor and control unit 660 can provide information in text and/or graphical format to these PDAs. Cellular phones may be able to receive text, audio, and/or graphics depending on their designs and capabilities. Monitor and control unit 660 thus provides information in the appropriate format to the remote devices based on their capabilities.

Various monitoring and reporting schemes may be employed to respectively receive information from the head-end and report the information to the remote devices. Some of these monitoring and reporting schemes are described below. Other schemes may also be contemplated and are within the scope of the invention.

In one monitoring and reporting scheme, monitor and control unit 660 polls IPG service manager 640 and session manager 650 for various operational status, some of which are respectively shown in FIGS. 7 and 8. Monitor and control unit 660 then receives the polled status and reports all or some of the received information to one or more remote devices 670 via server 662.

In another monitoring and reporting scheme, monitor and control unit 660 polls IPG service manager 640 and session manager 650 for error conditions (also referred to as "traps"). These error conditions may be generated based on (1) the observed operational status for various parameters at the head-end, and (2) a set of defined limits for these parameters. If any error conditions occur, monitor and control unit 660 is notified by the responsible entity (e.g., IPG service manager 640 or session manager 650). In response to receiving an error condition, monitor and control unit 660 sends alert messages to one or more remote devices.

In yet another monitoring and reporting scheme, IPG service manager 640 and session manager 650 send status and/or error conditions (e.g., periodically, upon occurrence of events, and so on) to monitor and control unit 660, which then reports the information to the remote devices.

The status, alert messages, and other data may be reported to a number of remote devices (i.e., personnel) designated to receive the information. The list of designated recipients may be maintained by monitor and control unit 660. For each recipient remote device, monitor and control unit 660 may maintain the identity of the remote device, its type (e.g., cellular phone, pager, PDA, and so on) and capabilities (e.g., text, graphics, audio, video, and so on), the particular type(s) of status and alert messages to be reported (i.e., the reporting level), and so on. In this manner, monitor and control

unit 660 is able to report the required information to the proper remote devices using the appropriate formats.

Table 1 lists the information that may be collected for each remote device designated to receive status and messages from monitor and control unit 660. This information may be entered via an interface menu, which may be activated, for example, by clicking on a button 740a in control monitor 700.

Table 1

Device ID	Type	Format	Reporting Level
1	pager	text	all
2	cellular phone	text	alert messages
3	PDA	text, graphics	status
4	pager	text	alert messages
5	PDA	text, graphics	all

If a personnel with a remote device receives status and/or alert messages, the personnel may respond in numerous ways. For one type of response, the personnel simply reports to the site to trouble shoot and correct any problems that may have arise for the system. Alternatively, the personnel may be able to trouble shoot the problems off-site and send commands back to monitor and control unit 660, which then forwards the commands to the responsible entity (e.g., IPG service manager and/or session manager) within the targeted head-end. Encoding/transport stream generation/delivery unit 620 within the head-end may then be adjusted and/or controlled based on the received commands.

In FIG. 6, monitor and control unit 660 is shown as being a separate unit that couples to one or more head-ends 602. In alternative embodiments, the functionality of monitor and control unit 660 may be incorporated into one or more head-ends.

For clarity, the remote monitoring and control techniques are described for an IPG delivery system. These techniques may also be used for numerous other types of information distribution system, such as data delivery systems, program delivery systems, and so on.

The foregoing description of the preferred embodiments is provided to enable any person skilled in the art to make or use the invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic

principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.